Contents

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On the cover:

This photograph of Georgiana Slough is from *Delta Country*, written by Richard Dillon and photographed by Steve Simmons. This book gives a historical overview of this timeless land, from the day of the American Indians and early explorers to settlement and development of today's agribusiness. The book also outlines the uncertain future of the Delta.

The *Layperson's Guide to the Delta* is prepared and distributed by the Water Education Foundation as a public information tool. It is part of a series of Layperson's Guides that explore pertinent water issues in an objective, easy–to–understand manner.

The mission of the Water Education Foundation, a nonpartisan, nonprofit organization, is to develop and implement education programs leading to a broader understanding of water issues and to resolution of water problems. For more information contact:

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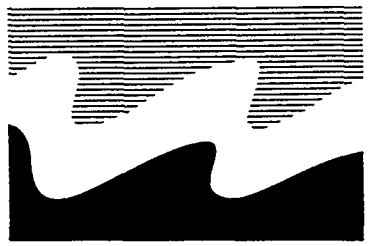

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Introduction

Flowing south, fed by northern Sierra Nevada runoff, the mighty Sacramento River meets the northbound San Joaquin River just south of Sacramento to form the Sacramento–San Joaquin Delta. Here the Sacramento and the San Joaquin — California's two largest rivers — mingle with smaller tributaries to form a 700-mile maze of sloughs and waterways surrounding 57 reclaimed islands.

The rivers' combined fresh water flows roll through the Carquinez Strait, a narrow break in the Coast Range, and into San Francisco Bay's northern arm. Suisun Marsh and adjoining bays are the brackish transition between the rivers' fresh water and the salt water of the Bay. The Bay-Delta Estuary is the largest estuary on the West Coast of North America, where the mix of fresh and salt water provides a unique environment supporting diverse plant and animal life.

The area always has been at the mercy of river flows and tides. Before humans changed the Delta environment, salty ocean water from the Bay crept up Delta channels during dry summers when mountain runoff ebbed. Then, during the winter, heavy runoff from the mountains kept the sea water at bay. The diaries of early Spanish explorers and more recent records illustrate that the salt line moves according to the dryness of the year. A great flood in the 1860s resulted in a substantially fresh water Bay. Conversely, salt water reached as far as Sacramento in the 1930s, during one of the state's worst droughts. Today, upstream dams help control salt water intrusion by releasing fresh water into the Delta system.

The Delta, as we know it, is a human invention. Early explorers found a vast marsh covered with bullrushes, called tules, and teeming with fish, birds and other wildlife. Through the 1700s and early 1800s, trappers took advantage of the abundant wildlife. They were followed by farmers, some of them unsuccessful gold-seekers, who discovered in the Delta wealth of another sort — fertile soil. More than a century ago, these farmers began building a network of levees to drain and "reclaim" this fertile soil.

Progressively higher levees were built to keep the surrounding waters out, the lands were pumped dry and the marsh was transformed into productive island farms. By 1930 more than 1,000 miles of levees surrounded close to 500,000 acres of farmland.

Many of those early farms remain in business today, but in addition to its local importance, the Delta is crucial to the state's overall water picture — it is the heart of California's two largest surface water delivery projects, the State Water Project (SWP) and federal Central Valley Project (CVP). Since the 1940s, its existing channels have been used to transport water to the projects' pumps in the western and southwestern Delta. From the Delta, water is transported south and west through canals and aqueducts to cities in the north and south Bay Area, millions of acres of San Joaquin Valley farmland and more than 15 milion people in southern California.

Water that historically flowed into the Delta also is diverted upstream — before it reaches the Delta — for use on local farms and in distant cities. Up stream exporters include the East Bay Municipal Utility District (EBMUD), which diverts Mokelumne River water, and San Francisco's Hetch Hetchy project, which diverts Tuolumne River water. Individual farmers and irrigation districts also pump water from the Sacramento and San Joaquin rivers and their tributaries upstream of the Delta to irrigate crops.

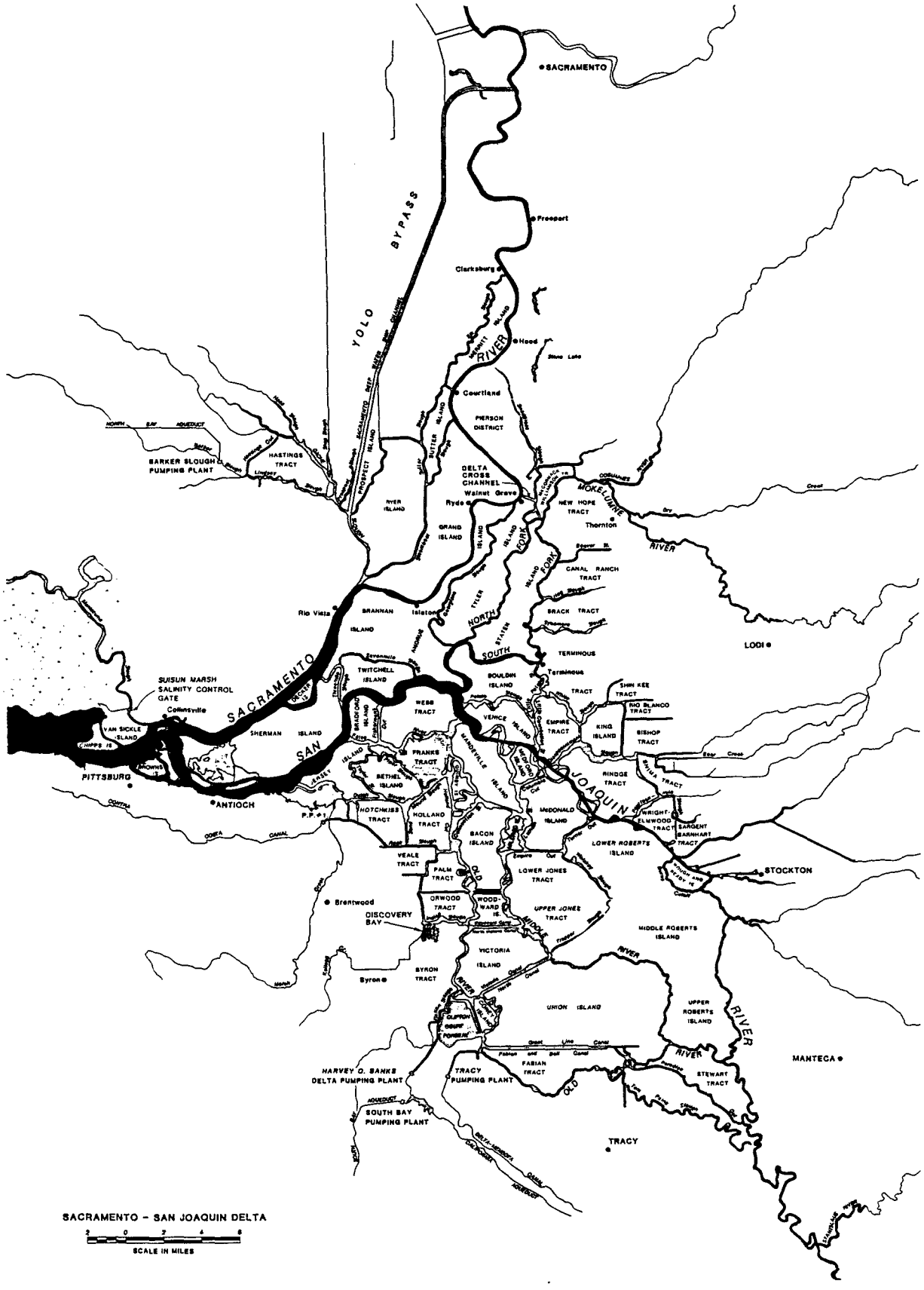
In total, more than 7,000 diverters obtain water from Delta tributaries or the Delta itself. Two–thirds of the state's residents rely on the Delta for at least a portion of their drinking water, and Delta farms remain an agricultural cornucopia, with $480 million in annual farm receipts.

The Delta also is the state's most important fishery habitat. An estimated 25 percent of all warm water and anadromous sport fishing species and 80 percent of the state's commercial fishery species either live in or migrate through the Delta. Populations of several species — including striped bass and chinook salmon — have declined because of a combination of drought, entrainment in

pumping facilities, poor water quality and the presence of non-native species that compete for food. Populations of striped bass, an introduced sport fish, have fallen to the lowest level since measurements began in 1959 — a decline viewed by many biologists as an indicator of the overall health of the estuary. One of four Sacramento River chinook salmon runs, the winter–run, and the Delta smelt, a small fish found only in the Delta, have been declared threatened species under the federal Endangered Species Act (ESA), requiring changes in water project operations to help protect them.

Comprising just 1 percent of California's total area, the Delta is at the heart of both the state's water supply system and water controversies. This Layperson's Guide is intended to provide the reader with a basic background on one of the most fought-over areas in California — the Sacramento-San Joaquin Delta.

This guide's companion is the *Layperson's Guide to San Francisco Bay.* Both are part of a continuing series of guides published by the Water Education Foundation. Other titles in the series include the Layperson's Guides to *California Water, California Rivers and Streams, Water Rights Law, Drinking Water, Flood Management* and *Water Conservation.*



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Chronology

The combined Bay–Delta American Indian population peaked at about 50,000 prior to the arrival of the Spanish.

1772 First recorded sighting of the Delta by Spanish explorers Father Juan Crespi and Pedro Farges.

1849 Settlers begin farming in the Delta, one year after discovery of gold in California.

1861 State Legislature authorizes Reclamation District Act allowing drainage of Delta lands and construction of sturdier levees to protect the area from flooding.

1937 Congress approves the Rivers and Harbors Act, authorizing construction of the federal Central Valley Project (CVP).

1951 The State Feather River Project (now State Water Project or SWP) authorized by Legislature.

1959 Delta Protection Act enacted to resolve some issues of legal boundaries, salinity control and water exports.

1960 Burns-Porter Act ratified by voters a $1.75 billion bond issue to finance the SWP.

1965 Department of Water Resources (DWR) selects Peripheral Canal as the SWP's Delta facility.

1971 State Water Resources Control Board (State Board) issues Delta Water Rights Decision 1379 establishing water quality standards for the CVP and SWP.

1973 First SWP deliveries to southern California.
After a 10–year study of Delta environmental problems, state Department of Fish and Game (DFG) concludes Peripheral Canal is best Delta water facility.

1974 DWR, DFG, U.S. Bureau of Reclamation (Bureau) and U.S. Fish and Wildlife Service sign a statement of intent that agencies will provide protection of Delta fish and wildlife.

1975 Department of Interior releases opinion that the federal Water Pollution Control Act does not require CVP water releases for salinity repulsion in the Delta.
DWR releases legal opinion that the federal Water Pollution Control Act does apply to CVP.

1977 After reviewing nearly 40 alternatives, DWR reaffirms that the Peripheral Canal is best Delta transfer facility.

1978 State Board issues Water Rights Decision 1485 (D–1485) requiring CVP and SWP operation to meet Delta water quality standards.

1979 Bureau announces CVP will voluntarily comply with D–1485 until legal questions of mandatory compliance are resolved.
Senate Bill 200, specifying construction of the Peripheral Canal, is introduced in Legislature.

1982 Voters defeat Proposition 9, which includes the Peripheral Canal SB 200 package, by 3-2 margin.

1983 DWR releases report analyzing four through-Delta water transfer alternatives to Peripheral Canal.

1984 Gov. Deukmejian proposes utilizing natural Delta channels and reconstructed levees. By June, "Duke's Ditch" is shelved.

1986 Historic DWR–Bureau accord, the Coordinated Operation Agreement (COA) is authorized by Congress.
"Racanelli decision" strengthening powers of State Board to protect all uses of Delta water affirmed by state Supreme Court.
DWR and DFG sign Delta Pumping Plant fishery mitigation agreement for direct fish losses.

1987 U.S. Environmental Protection Agency (EPA) informs state that D–1485 is not adequate to protect Bay–Delta water quality.
State Board begins Bay-Delta Proceedings to revise D–1485.

1988 SB 34 providing $120 million over 10 years for levee maintenance approved by state Legislature.
Suisun Marsh salinity control gates begin operation.
Construction begins on four additional pumping units at the SWP Delta Pumping Plant.
State Board releases proposed new Bay–Delta standards to boost instream flows and reduce water exports. Draft plan is subsequently withdrawn after water users protest.

1989 Sacramento River winter–run chinook salmon is declared a state endangered and federal threatened species. By 1992, measures to protect the fish are in place, requiring operational changes in CVP and SWP.

1991 State Board releases new salinity control plan for Bay–Delta; announces that flow and water right requirements will follow in separate plan.
EPA rejects portions of plan under Clean Water Act; calls upon state to adopt more–stringent standards or face federal rules.

1992 In statewide water policy statement, Gov. Wilson declares the Delta "broken" and asks State Board to set interim protection standards while a long–term solution is sought.
President Bush signs CVP Improvement Act, which allocates 800,000 acre–feet of water annually to environment.
State Board releases draft D–1630, interim standards for the Delta requiring reductions in exports to protect wildlife resources.

1993 Delta smelt declared a federal and state threatened species.
Gov. Wilson says federal actions in the Delta have rendered D–1630 standards "moot," asks State Board to drop plan.
State Board announces it will not adopt D–1630; resumes work on permanent standards to replace D–1485.
EPA says it will proceed with setting federal Bay–Delta standards

Background

Early History

Europeans first sighted San Francisco Bay in 1769 when a party of Spanish explorers in search of Monterey mistook San Pablo Bay for an arm of the Pacific Ocean. On a subsequent journey in 1772, Pedro Fages and Father Juan Crespi reached San Pablo Bay and wrote the first account of the Delta from a vantage point high on Mt. Diablo. With the Sacramento River overflowing its banks, the explorers' report to the crown of Madrid spoke of a "great inland lake that stretched farther than the eye could see, abounding with game, fish and fowl of all kinds."

Crespi was the first to write about the abundant wildlife in the Delta region, which provided ample food for the first known human inhabitants of the estuary, American Indians. Some 10,000 years ago, these people came south from Alaska and the Pacific Northwest, settling in parts of California. The combined Bay–Delta American Indian population peaked at about 50,000 prior to the arrival of the Spanish. (Within 100 years of the Bay–Delta's "discovery," most of the American Indian population was decimated, primarily because of the spread of European diseases such as measles.)

By 1776 the Spanish had established a mission at the site of San Francisco, one of 21 strung along the coast of California. The missionaries grew dry–land wheat and barley, and cultivated fruits and vegetables by irrigating with nearby river water. Beginning in the 1790s, Delta wildlife began to support a growing fur–trading industry. In 1827, American adventurer Jedediah Smith trapped beaver, otter and mink on the periphery of the giant marsh and blazed a trail north to Fort Vancouver, where his tales of the wealth of animal pelts yielded by the Delta were heard with keen interest by the Hudson Bay Company.

During the next 15 years, trappers were a familiar sight in the Delta. Seagoing ships navigated the Sacramento and San Joaquin rivers with supplies for upriver settlements and took out tallow and an increasing number of animal skins.

The Delta suffered enormous damage from vast amounts of sediment and debris swept downstream from hydraulic mining in the mountains. Hydraulic mining was widely used prior to being outlawed in 1884.

California's growth during this period was described as slow, but steady. All that changed in 1848 — gold was discovered in the Sierra Nevada foothills, and the stampede to California was on. Between 1848 and 1850, the state's population grew from 15,000 to 93,000.

The increasing use of hydraulic mining (the use of high–pressure jets of water to expose gold ore) in the 1860s changed the face of the Delta as mud, sand and gravel washed from Sierra foothills flowed into rivers and on downstream into the Delta, choking channels and raising the bottom of the estuary.

Delta Agriculture

By 1860, settlers disappointed by the scarcity of gold turned to one of California's richest resources — its fertile soil. They settled throughout the Sacramento–San Joaquin Valley region and began to farm. The Delta's rich soil and federal laws encouraging reclamation of swampland prompted settlers to begin draining and reclaiming the marsh. But Delta farming wasn't without peril. The land was constantly threatened by flooding, and using Chinese laborers, farmers began building small levees to hold back flood water. Their efforts were mostly futile, as the levees were able to hold back little more than a high tide.

During the second half of the 19th century, great strides were taken in converting the Delta into an agricultural area. New techniques were tried as part of these reclamation efforts. Mechanical power was applied to dredging, levee building and land clearing. Pumps were introduced in 1876 to control water levels on reclaimed land.

Levee–building projects ultimately turned what was once an uncontrolled marsh-land into a productive agricultural area. By 1880, the amount of reclaimed area was 100,000 acres; by 1900, it had reached 250,000 acres. During the next 30 years, the amount of reclaimed land grew to almost 450,000 acres, all of this accomplished by local interests.

At the same time successful farming burgeoned in the Delta, new species of fish were introduced into the Bay–Delta waters. Striped bass, American shad and white catfish were brought to the Delta. These introduced fish species flourished and along with the intrinsic salmon runs found in California streams and rivers helped support commercial fisheries. From 1873 to 1910 as many as 21 canneries in California processed 5 million pounds of salmon annually from the Sacramento and San Joaquin rivers. Along with fish, game birds, orchard and field crops, new breeds of livestock also were imported into the region.

Water Development

Even as agriculture flourished, commercial fishing expanded and the state's population exploded, the Delta suffered enormous damage from vast amounts of sediment and debris swept downstream from hydraulic mining in the mountains. The problems began in the 1860s, but even after an 1884 federal court injunction halted hydraulic mining, silt continued to settle in the Delta, altering navigable channels and hindering shipping activity.

The silt reduced Delta channels' carrying capacity, increasing the danger of flooding. Periodically, the channels were dredged to remove the silt. (Dredging continues today.) There also were problems with flooding in the Delta and upstream in Sacramento. The combination of flooding problems (primarily in the winter and spring), summer salinity intrusion (which damaged Delta crops), and the need for water in other regions of the state sparked interest in water storage and delivery systems.

Among the first to pursue water development projects were two booming Bay Area metropolitan regions, both tapping pure Sierra Nevada streams high above the Delta. In 1908, San Francisco chose the Tuolumne River, which flows through the western slopes of the Sierra Nevada, as a supply, and the Hetch Hetchy Valley in Yosemite National Park was selected as a dam site. Controversy over developing the reservoir brewed for decades, with John Muir, the great conservationist and founder of the Sierra Club, heading the fight against development. But in 1913 Congress passed the Raker Act, authorizing the project, and in 1923, with the completion of O'Shaughnessy Dam, the Hetch Hetchy Valley was flooded. Today, water from the reservoir is transported to San Francisco and pennisula cities via the Hetch Hetchy Aqueduct south of the Delta.

Across the bay, residents of Alameda and Contra Costa counties voted in 1923 to form EBMUD to meet the region's growing water needs. Seeking the purest source of water possible, the district turned to the Sierra watershed of the Mokelumne River. Today three parallel aqueducts carry this water 90 miles to East Bay reservoirs. The two Bay Area municipal water projects, combined with upstream agricultural diversions, reduced the Delta's historic fresh water flows.

Wintertime flooding and summertime Delta salinity intrusion sparked interest in a statewide water project. Above, flooding on the Sacramento River in the 1940s.

While local water projects satisfied some irrigation and municipal needs and reduced threats of flooding, government officials continued to pursue a statewide water system. In 1921, the state Legislature authorized an extensive investigation to develop a comprehensive water plan. For the next 15 years, federal, state and local interests wrangled over how to best supply California with a dependable source of water that would reduce flooding and salinity intrusion. In 1933, the state's voters approved the CVP Act, authorizing construction of reservoirs to supply water and provide a hydraulic barrier to repel sea water intrusion. But the project could not be financed by the state during the Depression.

The state turned to the federal government for help, and in 1937, the Rivers and Harbors Act authorized construction of the CVP. Unlike the state plan, the federal legislation did not include salinity control as a project purpose. Instead, the CVP was authorized for flood control and navigation, water supply for agricultural and municipal purposes, and hydroelectric power generation. Construction began in the 1940s, and by 1951, most of the initial features of this massive water delivery system were completed.

The use of Delta channels as conduits for transporting water began in 1940 with completion of the Contra Costa Canal, the first unit of the CVP. With the 1951 completion of the Delta-Mendota Canal, the Delta became part of a vast water export system. Also in 1951, the Delta Cross Channel was constructed near Walnut Grove to facilitate the transfer of water from the Sacramento River across the Delta to the CVP export pumps located near Tracy. (Also part of the CVP is Friant Dam on the San Joaquin River. The dam captures fresh water flows that normally would enter the Delta and diverts it via two canals.)

World War II brought another boom in population. Workers who came to California to support the war effort stayed after the war to raise their families. State water planners recognized the need for supplemental water to support urban growth in southern California and prevent ground water overdraft in the San Joaquin Valley.

In 1951 the state authorized the Feather River Project, later known as the SWP. After years of debate, discussion and study, the project was ratified by voters in 1960. Leading the effort to resolve California's long-standing water conflicts was Gov. Edmund G. "Pat" Brown. In 1967, the state also began pumping water from the Delta into the California Aqueduct, part of the SWP which today serves the north and south Bay Area and the San Joaquin Valley, as well as most of densely populated southern California. By 1975, the combined deliveries of the SWP and CVP, both north and south of the Delta, had grown to about 4.8 million acre-feet: by 1988, the total reached around 10.6 million acre-feet.

ne Delta Today

ies are coastal areas where fresh from rivers mixes with ocean water where salinity (saltiness) is between extremes of sea water and fresh The Delta, Suisun Bay, San Pablo and south and central San Francisco form such an estuary — the largest the West Coast.

ne Bay–Delta estuary's major source of water comes from the Sacramento San Joaquin rivers. The sea water ies from the Pacific Ocean via tides. resh water, which is less dense than water, moves on the surface of the estuary's currents, while heavier salt water flows closer to the bottom. The area where the bottom and surface currents interact most intensely is called the "entrapment" or "null" zone. High concentrations of algae, fish and eggs congregate in this zone, making it an important nurturing area for plants and animals. The location of the entrapment zone moves back and forth from the Delta to near San Pablo Bay, depending on fresh water outflow and ocean tides. The saltiness of Suisun Bay — the largest, unbroken brackish water marsh habitat in the United States — varies according to the time of year (saltier in the fall) and type of water year (saltier in dry years). Because Suisun Marsh is so important for fish and wildlife, much attention has focused in recent years on the bay's water quality.

Like the Delta, the Bay Area portion of the estuary as we know it is different than that viewed by early explorers. The biggest change is in its size; since 1850, the estuary has shrunk from 787 square miles to 548 square miles, primarily because of debris from hydraulic mining and the intentional filling of tidal wetlands for industry and other urban uses.

With its transformation from marsh to farmland, the Delta portion of the estuary is comprised of numerous below–sea-level islands protected by levees. The surrounding waterways serve as passageways for fish, and the levees provide valuable habitat for a wide variety of wildlife.

The steamboats and barges of yesterday that ferried the Delta waterways to deliver supplies and transport passengers have been replaced today by thousands of houseboats and power boats — the Delta is one of the most popular recreational spots in the state. Its islands offer camping, hiking, sightseeing, bicycling and horseback riding while Delta channels offer boating, waterskiing and fishing. All these recreational activities contribute money to the local economy, but they also increase pressure on the estuary. For example, wave action produced by boats' wakes cuts into levees, causing erosion.

In addition to its agricultural, recreational and wildlife values, the Delta is vitally important because of its geographical location — it serves as the switching yard for water supplies for the CVP and the SWP. Two–thirds of the state's residents receive at least a portion of their drinking water from the Delta. Consequently, whatever affects the Delta affects large portions of northern, central and southern California.

The significance of the Delta is illustrated by the number of state and federal governmental agencies, in addition to local water districts and city councils, involved in Delta issues. California agencies with an interest in Delta issues include the Department of Water Resources (DWR), which manages the SWP; the Department of Fish and Game (DFG), which oversees fish mitigation efforts, administers the state ESA and regulates hunting and fishing; the State Water Resources Control Board (State Board) and its Regional Water Quality Control Boards, which set water quality standards and oversee water rights issues; and the State Lands Commission (SLC), which is responsible for administration of tidal and navigable waterways.

Federal agencies involved in Delta issues include the Bureau of Reclamation (Bureau), which operates the CVP; National Marine Fisheries Service (NMFS), which oversees protective measures for the winter–run chinook salmon; U.S. Fish and Wildlife Service (USFWS), which oversees protective measures for the Delta smelt; U.S. Army Corps of Engineers (Corps), which oversees levee maintenance and dredging; and the U.S. Environmental Protection Agency (EPA), which administers the Clean Water Act.

The many agencies — and their sometimes conflicting agendas — illustrates how complicated and controversial Delta issues can be. Each of the Delta's problems, be it preserving fisheries, maintaining Delta levees or providing water for agricultural and urban needs throughout the state, brings with it opposing points of view. For the most part, past studies and programs have taken a piecemeal approach to exploring and managing the Delta. It is only recently that state and federal studies, legislation and programs, such as the ones outlined in this guide, have begun to address the estuary as a whole.

Wave action from the thousands of boats that traverse the Delta waterways can cause levees protecting Delta farmland to erode.

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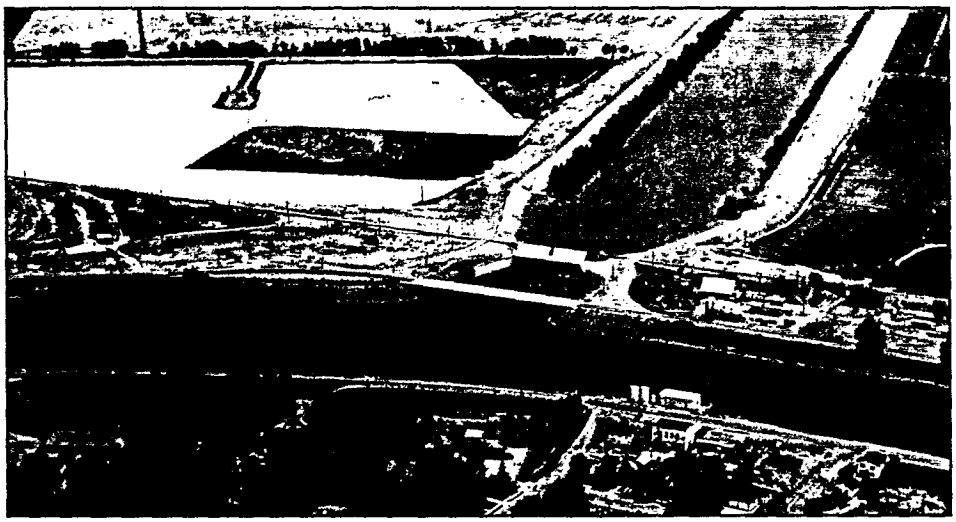
Delta Issues



The Delta Cross Channel near Walnut Grove, part of the CVP, carries Sacramento River water south and west to the export pumps near Tracy.

Water Distribution

With construction of the CVP and SWP, the Delta became a critical link in the state's complex water distribution system. The Delta's channels transport water from upstream reservoirs to the south Delta, where state and federal facilities (the Harvey O. Banks Delta Pumping Plant and the Tracy Pumping Plant) pump water into the California Aqueduct and CVP canals.

These projects and local facilities also provide water to more than 4 million acres of irrigated farmland, primarily in the San Joaquin Valley, and 20 million people in central and southern California and portions of the Bay Area. All in all, the Delta is a partial or total source of drinking water for two-thirds of the state, and reliance on Delta waters is expected to increase.

The 1990 census confirmed that California is undergoing the greatest population surge in the state's history. Over the past decade, the state experienced a 25 percent growth rate — double the national average — surging to 30 million residents. Growth slowed some in the early 1990s, when economic recession and other factors contributed to a drop in net migration (the difference between the number of people moving in and out of the state). Still, a 1993 report released by the state Department of Finance reported California's population at 31.3 million. State officials also predict a population of 36.4 million by the year 2000 and 63.3 million by 2040 — doubling the current population in 50 years.

When matching projected population demand with existing water supplies and facilities, DWR estimates that by 2000 the state will experience water shortages of various magnitudes in three out of four years. Gov. Wilson's Water Policy Task Force determined that given existing facilities, the statewide annual shortage could range from 4 million to 6 million acre-feet. Along with providing more reliable supplies for urban and agricultural users, a critical challenge for the future will be supplying more water for fish and wildlife.

Societal values have undergone fundamental change over the past century, evolving from an ethic of conquering nature to one of coexisting with it. This change in values, combined with powerful lobbying by environmental groups and the passage of strict state and federal laws protecting endangered species and plant and wildlife habitat, have effectively blocked most conventional water development over the past two decades. Present and past state administrations believe development of additional water for the state is crucial. But environmental groups oppose increased development of Delta water on the grounds that more diversions may further harm the estuary's ecosystem. Indeed, some groups argue for reduced Delta diversions to allow more fresh water to flow through the estuary. They contend new demands can be met by more efficient use or reallocation of already developed supplies from agricultural to urban uses.

Clearly, the key to resolving the Delta's very complex and controversial water issues lays in striking a fair balance between these urban, agricultural and environmental uses. In recent years, efforts have been made to reach consensus through the Three–Way Water Agreement Process, an ad hoc group of environmental, urban and agricultural water leaders who began meeting in 1990. The group did make strides toward its goal of finding a "broadly acceptable" framework that would be supported by all three interests, but was unable to resolve Delta issues. The group's work, however, formed the foundation of Gov. Wilson's 1992 water policy.

A century and a half after farmers first began tilling its fertile soil, the Delta remains an important agricultural region.

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Salinity and Agricultural Drainage

Historically, Carquinez Strait was the boundary between the fresh water from Delta rivers and the salt water of the Pacific Ocean. But salt water intrusion — especially in the summer, when mountain runoff ebbed — was a common problem. Early Spanish explorers noted the changing salt line as did Delta farmers, whose crops were often affected by salinity. Records show that the greatest salt water intrusion, the farthest advancement upstream from the ocean, occurred between 1920 and 1931. (The state's "great" drought began in 1928 and ended in 1934.)

The problem of seasonal salt water intrusion into the Delta was greatly alleviated by upstream dams and reservoirs. The year-round release of fresh water from CVP and SWP facilities helps keep sea water at bay. However, salinity intrusion from the ocean or accumulation of minerals from farming discharged into Delta rivers remains a problem. The estuary generally becomes saltier during the summer and fall, but can be influenced in spring months when export pumps are running at full bore to capture runoff. And environmentalists and fishery biologists say efforts to increase the Delta's summertime fresh water flows for human needs -- highly saline water affects agricultural production and municipal water quality -- in combination with maximum export pumping, has created a saltier estuary in the winter and spring, adversely impacting natural resources.

Historically, the need to keep the Bay's salty water away from the rich Delta soils and local farms was seen as essential, and as early as 1880 the state proposed building a barrier between the Bay and Delta. Over the years, several types of facilities have been studied to reduce salinity intrusion in the Delta and improve the transfer of water from the rivers to the export pumps.

Facilities studied have included hydraulic barriers, using upstream releases of fresh water to repel sea water (incorporated in today's water projects); physical barriers, such as low-level dams to separate fresh water from saline water with passageways for navigation and fish migration; alterations in existing channels to improve flow patterns; and construction of new channels, such as the Peripheral Canal, to isolate export water from brackish Delta waters.

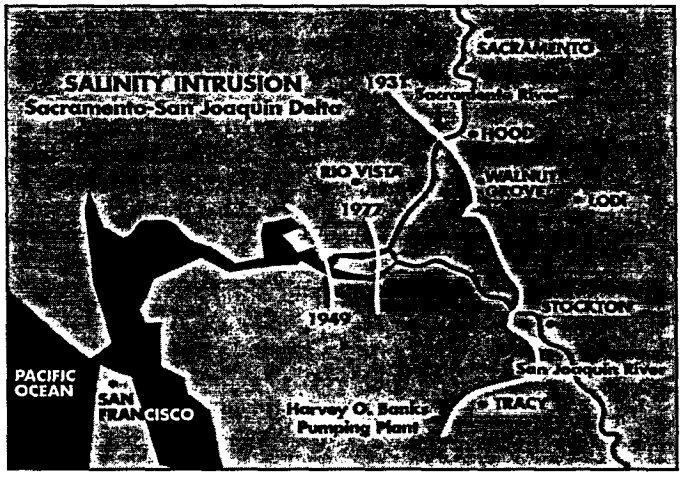
In comparison to the rest of the Delta, the western Delta (roughly the area west of Isleton) suffers periodically from higher salt water content with its possible adverse effect on drinking water supplies for the 400,000 residents of eastern Contra Costa County. The greater the amount of fresh water flow from the rivers to San Francisco Bay, the better the water quality in the western Delta. Since the 1960s, the State Board has set water quality standards in an effort to alleviate problems with salinity. (See page 14.)

Agricultural drainage also contributes to the Delta's salinity problems. Because most Delta islands are below sea level, water from surrounding channels seeps through the levees onto the land. Farmers, in turn, must pump this water from the lands to allow their crops to grow. However, farmers also must add controlled amounts of fresh water for productive agriculture.

In the South Delta, where farmers rely primarily on the waters of the San Joaquin River for their irrigation supply, the process of irrigation concentrates salts in the drainage water, which is then pumped into nearby Delta channels. Sometimes there is no current to "flush" these salts through the Delta, creating localized salinity problems.

The salt content of drainage water flowing down the San Joaquin River, primarily from the west side of the valley, is high, and sources of dilution water are limited. Most of the valley averages less than 10 inches of rain a year, and water from Sierra tributaries is now either exported or diverted for consumptive uses. Flows in some stretches of the San Joaquin River during the summer irrigation season consist almost entirely of irrigation return flows. This increases the salt content of water used downstream by Delta farmers and further increases salt concentrations in this water flowing into the estuary.

The quality of the water in the San Joaquin River and methods to control salinity are being explored by the San Joaquin River Management Program (SJRMP), a multi–agency group that has met since 1991 in an effort to draft a regional management plan. The SJRMP water quality subcommittee is focusing on better management of agricultural drainage, fish releases and water diversions to reduce the extreme fluctuations in salinity.



Map showing the intrusion of salt water into the Sacramento–San Joaquin Delta in 1949, after completion of Shasta and Friant dams; in 1931, a severe drought year prior to the completion of the CVP and SWP, whose fresh water releases help repel salinity; and in 1977, the state's driest year on record.

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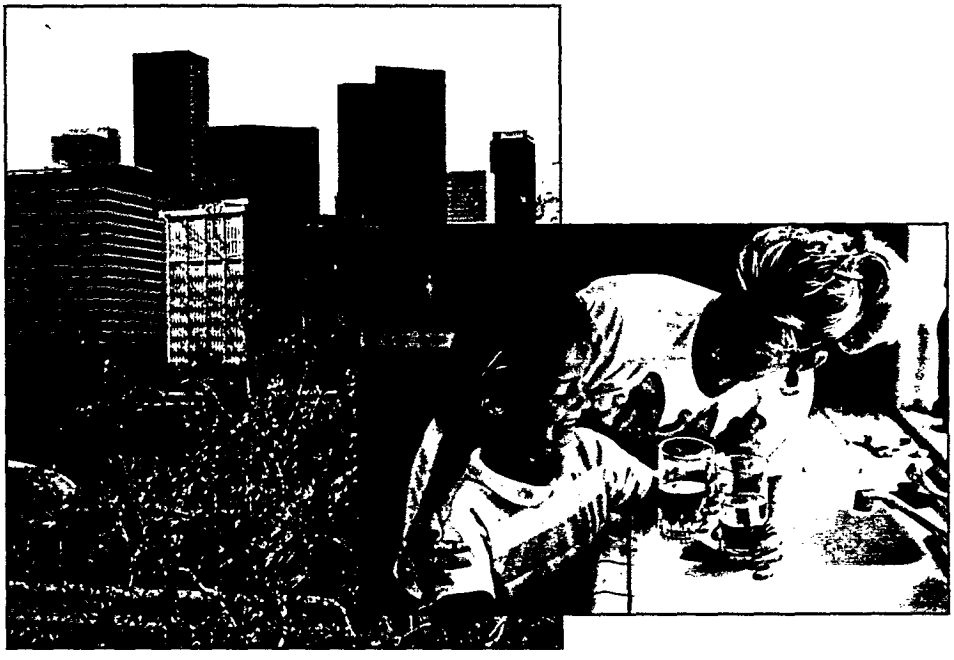


Two–thirds of the state's residents receive at least a portion of their drinking water supply from the Delta.

Drinking Water Quality

Since the Delta is a drinking water source for about 20 million Californians, the quality of this water is very important. Because the Delta was once a swamp, it has rich, organic soils containing compounds that are the building blocks for suspected human carcinogens called trihalomethanes, or THMs. As water from the Sierra rivers flows through the Delta, it picks up naturally occurring organic materials.

Since the 1970s, scientific studies have shown that chlorine — the disinfectant of choice for surface water — can combine with organic materials in raw water and form THMs during the treatment process. Some THMs, such as chloroform, are suspected to cause cancer in humans, leaving urban water suppliers and health officials with a difficult dilemma: a reduction in chlorine may decrease lifetime cancer risks from drinking Delta water, but could increase occurrences of short–term gastric illnesses.

The THM problem could cost urban water purveyors billions of dollars over the next few years in additional treatment costs as EPA officials weigh a possible more–stringent maximum contaminant level standard for chloroform and three other THM compounds. Those treatment costs, in turn, will be passed onto consumers, increasing water rates.

In recent years, water officials throughout the state have experimented with alternative treatment methods in an effort to reduce THMs but, at the same time, maintain adequate disinfectant to eradicate microorganisms that can occur in distribution pipelines between the treatment plant and the customer's tap. Studies have indicated, for example, that ozone disinfection reduces THMs. But officials also have found that ozone can combine with bromide, a component of sea water, which can intrude into the Delta and increase the salt content of water exported to the Bay Area and southern California via the SWP. When that water is treated, bromate can form, another possible carcinogenic disinfection by–product.

In 1992, the Metropolitan Water District of Southern California (MWD), a wholesale agency whose 27 member agencies supply water to about half the 15 million people living in Los Angeles, Ventura, Riverside, Orange, San Bernardino and San Diego counties, began testing a state–of–the–art drinking water treatment process at one of its plants. The plant has allowed MWD to test peroxone, a blend of ozone and hydrogen peroxide, on 5.5 million gallons of water each day. Small demonstration projects conducted by MWD since 1986 had shown this treatment method reduced disinfection by–products, while eliminating disease–causing, water–borne microorganisms and improving the taste of the water.

Preliminary results from the plant show promise, and MWD may switch to peroxone at its other treatment plants. Peroxone treatment would be less expensive than ozone treatment alone, and MWD officials say it will help them comply with future Safe Drinking Water Act restrictions for THMs. The current THM standard is 100 parts per billion. With its 1985 switch from chlorine to chloramine disinfection, MWD successfully reduced THM levels to 65 parts per billion. EPA, however, is expected to propose an 80 parts per billion standard by 1994 and there is speculation that a 40 parts per billion THM standard could be set by EPA in the late 1990s.

With peroxone in combination with chloramine treatment, preliminary tests at the MWD pilot plant show THM levels of 10 to 20 parts per billion — well below current and proposed future allowable levels. MWD officials say the process has also removed undesirable odors and tastes and provided effective disinfection of the drinking water.

The results of MWD's tests also could help other urban water suppliers decide on a treatment process. Other possible solutions to meet current and future THM levels include blending Delta water with another source, such as ground water, reducing agricultural drainage in the Delta or diverting water before it flows through the estuary via the Peripheral Canal.

Fish and Wildlife

The last century and a half have brought only physical changes to the Bay and Delta, but differences in the flora and fauna that inhabit the estuary. The historic Delta has been described as consisting of numerous low islands of tule marshes, intersected by miles of river, tributary channels and dead–end sloughs. The lowland marshes and waterways were surrounded by slightly higher seasonal flood plain grasslands and oak savannah.

Historic estuary fisheries included salmon, steelhead trout, sardines and herring. With the Gold Rush and the state's booming population, a colony of Italian immigrants formed the first commercial fishery between 1848 and 1852 — netting salmon in Central Valley rivers. The first salmon cannery was established in 1863, and records of commercial canning lead biologists to believe that salmon runs in the Sacramento and San Joaquin river basins once numbered in the millions. In 1882, the commercial salmon catch from the Sacramento River alone (primarily through river gillnets) was a record 12 million pounds.

In addition to salmon fishing in the rivers, commercial fisheries were founded throughout the Bay and Delta for smelt, sole, flounder, sardine, herring and anchovy. There were little controls on these fisheries, however, and overfishing caused a decline in native species. Early settlers responded by introducing new species, such as the American shad and striped bass, both of which supported commercial fisheries for many years. To boost salmon runs, a number of fish hatcheries were established.

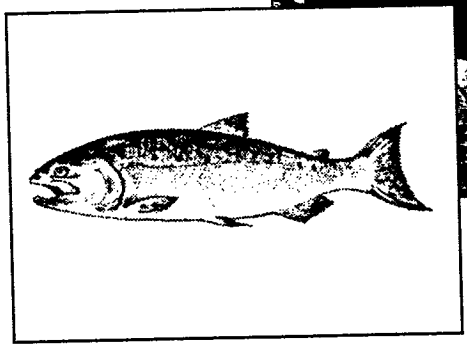
Fish populations, however, continued to decline, leading to commercial fishing bans on white sturgeon in 1901, steelhead trout in 1927, striped bass in 1935, and American shad in 1957. Chinook salmon continue to support a commercial fishery, but are now harvested in the ocean. Gill–netting on rivers (except for American Indian tribes in the Klamath River basin) was banned by the California Legislature in 1956. Other commerical fisheries that remain in the estuary today include Pacific herring, bay shrimp and crayfish. Popular sports fish include white catfish, largemouth bass, bluegill, steelhead trout and American shad.

Despite the commercial ban on striped bass (they remain part of the sport fishery), their numbers have declined dramatically since the early 1960s from about 3 million adults to an estimated 590,000 today. The striped bass is one of the most–studied fish in the estuary, and despite being an introduced species, it has served as an "indicator" species for many years because of its resource value and sensitivity to changes in the estuary. In its 1978 water quality control plan, the State Board (see page 14), established flow and salinity standards to protect striped bass. The goal of the standards was to maintain a Striped Bass Index (SBI) of 79: a value obtained by collecting, measuring and calculating the number of young striped bass. This goal has not been met; between 1978 and 1990, the SBI has averaged about 21.

Like the striped bass, numbers of chinook or "king" salmon in the Sacramento and San Joaquin river systems have dropped dramatically, and predation by striped bass is considered to be one cause for their decline. Four runs of salmon are found in the Sacramento, characterized by the time of year they pass under the Golden Gate Bridge on their upstream journey to spawn — fall, late–fall, winter and spring. Most attention has been focused on the winter–run, which was declared a state endangered and federal threatened species.

The winter–run population reached its lowest point in 1991 when only 191 adults returned to the Sacramento River to spawn — a fraction of the 117,000 winter–run estimate of 1969. However, it appears efforts to restore the run through alterations in Delta pumping and upstream water releases may have helped; 1,180 winter–run returned in 1992. Other salmon runs, however, have continued to decline in population, and there is potential that the Sacramento River's spring–run and the San Joaquin River's fall–run may be proposed for protection under the ESA.

A number of factors are blamed for the decline in striped bass and salmon, both of which are anadromous fish — migrating between fresh and salt water to complete their life cycles. These factors include the severe 1987–1992 drought, the introduction of new species, changes in food supply, loss of habitat, oceanic conditions and water diversions. But there is considerable debate over how large a role water diversions have played in this decline, and whether state, federal and local pumps have caused or exacerbated the problems. There also is considerable debate over whether



Left: Chinook salmon numbers have dropped dramatically. Above: Suisun Marsh is an important stop for migratory waterfowl along the Pacific Flyway.

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technological fixes, such as better fish screens on diversion pumps, or more fresh water flows will do the most to help restore these resources.

In addition to efforts to restore the winter-run salmon, 1993 brought an event that could eventually dictate the operation of all Delta water transfer facilities and the volume and timing of water exports. The Delta smelt, a 3-inch fish that lives only in the Delta, was declared a threatened species under the state and federal ESAs. Biologists maintain that the smelt population has declined 90 percent over the past decade, but opinions differ on the cause of the smelt's decline. While some biologists blame fresh water diversions during the spring months, others maintain there is no evidence to link declining smelt populations and available water in the Delta.

Water officials fear they will be forced to further reduce exports and modify water project operations to protect the smelt. But environmentalists argue that the smelt, like the striped bass and salmon, is an indicator that the health of the estuary is declining. Two other fish found only in the Delta, the Sacramento splittail and the longfin smelt, are candidate species for protection under the ESA.

One other possible cause for the smelt's decline, and for other changes in estuary fisheries, is an Asian clam believed to have been accidentally introduced in the Bay–Delta. Since its discovery in 1986 the clam, potamocorbula amurensis, has multiplied dramatically and dominates other bethic, or bottom–dweller, organisms such as oysters and crabs. The Asian clam has consumed great quantities of phytoplankton, a microscopic plant that supplies food for zooplankton, a microscopic animal. These organisims form the base of the food chain, and biologists fear their decline is adversely affecting young salmon and striped bass. Some observers say the clam is a more serious threat to salmon and striped bass survival than water diversions, and maintain that until something is done about this exotic species, any increase in fresh water outflow will be wasted.

In addition to the 130 fish species that call the estuary home, 380 animals can be found within the ecosystem. Most of the animals are birds, as the estuary offers important wintering habitat for the millions of traveling ducks and geese on the "Pacific Flyway," a major north-south migration route. Amphibians, reptiles and mammals also are found within the estuary.

The Public Trust Doctrine

Under the provisions of the public trust doctrine, the State Lands Commission (SLC) is the trustee of more than 4 million acres of state-owned rivers, streams, sloughs, lakes, tidal bays, marshes and beaches in California. The public trust doctrine holds that certain resources belong to the public. The state, as a sovereign, takes title to tidelands and the beds of non-tidal navigable waters and is charged with managing these lands for the benefit of all. State ownership also extends to the rivers' banks and includes riparian habitat. The SLC grants permits or leases for the use of these lands.

The original role of the public trust doctrine was to protect the public's right to navigation, commerce and fishing. But under a historic California Supreme Court decision in 1983, the doctrine was further held to protect recreational, scenic and environmental values. It also was extended to the tributaries of navigable waters, such as the small streams that drain into Mono Lake. In National Audubon Society vs. Los Angeles Department of Water and Power, a suit involving diversions from streams feeding Mono Lake, the California Supreme Court held that long-standing rights (such as Los Angeles' right to divert water from eastern Sierra streams for transfer to southern California) could be challenged to provide additional water for environmental protection.

As trustee, the SLC has recently begun assessing the state's water resources and has encouraged cooperative river management among various governmental agencies. To further the development of river parkways throughout the state, the SLC has sponsored legislation to promote river greenway planning and management programs.

Delta Levees

Since the 19th century, more than 1,000 miles of levees have been built to protect "reclaimed" Delta islands. Many of the islands are 25 feet or more below sea level and the water in the surrounding channels. The levees were built to prevent flooding and allow cultivation of the rich soil. Yet on many islands, the levee foundations are composed of the same peat soil formed by the marsh's original vegetation. This organic soil is rich in nutrients, but oxidizes and compacts at the rate of about 3 inches per year. This compaction, known as subsidence, is a critical problem because the process stresses levees and increases the probability of island flooding.

A sound, well-maintained levee system is vital to protect not only the farms and towns on Delta islands, but the supply of fresh water moving through Delta waterways. When levees fail, water rushes into the lower-than-sea-level islands. This water tends to be salty because it is drawn upstream from the Bay. If levees collapse when there are lower fresh water flows (such as during a drought year) to counter the pressure of the sea water, salt water would intrude farther into the Delta and the water that supplies millions of people and acres of farmland.

Since 1980, 17 Delta islands have been partially or completely flooded. Numerous studies have found that Delta levees are deteriorating, and that their repair and maintenance will cost hundreds of millions of dollars. In some instances, local efforts to repair and maintain levees have come in conflict with state laws protecting riparian vegetation. Delta levees are classifed as project or nonproject. Project levees are part of the Federal Flood Control Project and are maintained by the Corps. Non–project levees, comprising 65 percent of Delta levees, are those constructed and maintained by island landowners or local reclamation districts. These levees are generally considered less stable than those constructed and maintained by the Corps.

After the floods of 1986, Senate Bill 34, the "Delta Flood Control Protection Act of 1988," was enacted. It provides $12 million a year for 10 years to increase funding for levee improvements, and develop flood control plans for the eight western Delta islands and the communities of Thornton and Walnut Grove. In 1991, SB 1065 was passed, significantly changing the SB 34 program by requiring DFG to approve all applications of Delta construction to make sure wildlife habitat is protected. In addition, the Corps, DWR and the Reclamation Board initiated a six–year study in 1991 of flood control and environmental needs in the Delta.

Another possible threat to levee stability is an earthquake. A number of major quakes have rattled northern California, such as 1989's 7.1 Loma Prieta earthquake, and geological studies have located numerous fault lines running through or near the Delta. Whether such a quake would cause the Delta's fragile levee system to collapse, however, is an issue of dispute.

Water officials fear a major quake could cause the levees to "liquefy" and fail. (Liquefaction occurs when the earth shakes and saturated sand starts to flow like liquid. Quicksand is an example of liquefaction.) If the levees liquefied, according to this theory, salt water would flood many Delta islands, forcing Delta water users throughout the state to rely on stored supplies and seriously disrupting water delivery to central and southern California.

Under terms of an emergency response plan drafted by DWR, water suppliers would stop the CVP and SWP Delta pumps, wait for the Delta to stabilize, and increase releases from Folsom, Shasta, and Oroville reservoirs to fill up the Delta with fresh rather than salt water. Once stabilized, work to patch up the levees and block salt water intrusion could begin. But many argue that massive Delta levee failure could not be so easily repaired — that the Delta is essentially a "weak link" in the state's water transportation system. Studies conducted for EBMUD, for example, concluded that long reaches of Delta levees built over sand pockets could liquefy under severe seismic loads and cause failure.

Others point out that the 1989 7.1 quake that devastated much of the metropolitan Bay Area was as close to the southern Delta as it was to San Francisco's Marina District — and that no damage occurred in the Delta. Some people contend that the earthquake theory, publicized in 1991 by large agricultural and urban water users, is an effort to rebuild support for the Peripheral Canal.

To help control subsidence and reduce levee failures, DWR is buying land on two Delta islands, near the point where salt and fresh water meet, and converting them from agricultural use to wildlife habitat. Tilling the soil for farming increases peat soil's exposure to sunlight, increasing oxidation and the potential for levee failure and flooding.

At left,a Delta levee. Note that the water level in the canal, to the left of the levee, is higher than the road and farmland to the right of the levee.

C-098549

Delta Decisions

D–1485

Beginning in the 1960s, the State Board has set Bay–Delta salinity and flow objectives to maintain water quality for local and statewide use. Those standards are periodically reviewed and revised. In 1978, the State Board, whose five members are appointed to four-year terms by the governor, adopted Water Right Decision 1485 (D-1485) and a Water Quality Control Plan (the Delta Plan) for the Delta.

The Delta Plan contained flow, salinity and operational objectives, while D-1485 placed permit conditions on the SWP and CVP to meet these objectives (allowing 5 million acre-feet Delta outflow), either by reducing export pumping or by releasing waters stored in upstream reservoirs — or both. An underlying premise of D-1485 and the Delta Plan was that water quality should be at least as good as it would have been had the state and federal projects not been built. The beneficial uses protected under D–1485 fall into three broad categories — fish and wildlife, agriculture, and municipal and industrial uses — and water quality standards were established for each of these. The standards provide adjustments for reduced water quality in dry and critically dry years, when less water is flowing into the Delta from the rivers that feed it.

When the State Board adopted the 1978 plan, it pledged to review it in 10 years to ensure that it provided a "reasonable" level of protection for fish and wildlife, agricultural and urban water users. It also called for additional fisheries and water quality studies and sampling and monitoring programs in an attempt to gain a better knowledge of the ecosystem and water quality needs for Delta agriculture, and to find answers to some of the persistent questions. For the first time, the State Board mandated studies of the projects' impacts on San Francisco Bay. (See page 17.)

In 1987, EPA notified the State Board that D-1485 standards were inadequate to protect the estuary. Because the State Board was about to begin a series of hearings — to modify D-1485 and the Delta plan, EPA did not impose its own standards. Meanwhile, a 1986 landmark legal ruling known as the "Racanelli Decision" greatly expanded the obligations and authority of the State Board, directing it to balance and protect all beneficial uses of Bay-Delta waters -- including fishery and other instream uses -- and to modify existing water rights if necessary to achieve that balance.

After gathering testimony from more than 150 agricultural, urban and environmental organizations and state and federal agencies during the Bay–Delta Proceedings, the State Board in 1988 issued a draft water quality plan for the Delta, which proposed both water quality and flow objectives. The 1988 document unleashed a storm of protest. Agricultural and urban water users insisted the plan would place too severe limits on exports, while fishery and environmental groups pushed for even stronger instream protection. Several weeks later, the State Board withdrew the draft document and announced it would begin anew, with the subsequent order to come in two separate actions: a water quality plan that would address only water quality issues such as salinity, temperature and dissolved oxygen, and a water right decision that would implement the water quality objectives and address flow standards and project operations criteria.

In May 1991, the State Board adopted a salinity plan for the Bay–Delta estuary that addressed temperature, salinity and water quality standards for the estuary, water flows to meet those standards. The issue of flows, the State Board said, would be addressed in the pending water right decision.

In September 1991, the EPA, citing a 13–year decline in striped bass and using its authority under the Clean Water Act, rejected key portions of the May 1991 plan. Specifically, EPA rejected the plan because it did not include salinity standards for Suisun, San Pablo and San Francisco bays. EPA officials instructed the state to revise its standards by December 1991, or face federally promulgated rules. However, the EPA said it would take at least a year to draft those federal water quality standards, giving state officials, in effect, until December 1992 to adopt flow standards or revise the salinity standards to address EPA concerns.

The Racanelli Decision

The 1986 Racanelli decision concluded that the State Board in issuing D-1485 had improperly narrowed its water quality planning to the protection of water rights (instead of the protection of all beneficial uses of Delta waters),and to the impacts on water quality of the state and federal projects (instead of the impacts of all factors and water users affecting water quality in the Delta).

This ruling, allowed to stand by the California Supreme Court, instructs the State Board to take into consideration all factors — not just the operation of the state and federal projects — which have a bearing on Delta water quality. The decision also said the State Board had improperly based its previous salinity objectives on levels that are needed to protect existing water rights, rather than determining what flows and salinity are needed to protect the various uses of Delta water.

The ruling distinguished the State Board's water rights and water quality planning authorities. In doing so, the court paved the way for more comprehensive water quality objectives and a broader program of implementation to obtain those objectives, including the regulation of non-project water rights and the recommendation of other non-regulatory measures.

D–1630

Despite EPA's actions, the State Board did not revise the salinity plan, instead continuing its work on the water right/ flows portion of its new Bay-Delta standards. With a final decision three years in the future, the threat of federally imposed water quality rules, project operational changes imposed under the ESA to protect the winter–run chinook salmon, and growing concern about drought-induced environmental damage, Gov. Wilson intervened. In April 1992, he called upon the State Board to set interim Delta standards by the year's end to halt the deterioration of the Bay–Delta's environmental resources. The standards were to allow a new Wilson–appointed commission, the Bay–Delta Oversight Council (BDOC) and the State Board three additional years to develop a long–term solution to "fix" the Delta.

In December 1992, the State Board subsequently released draft Delta Water Right Decision 1630 (D-1630), proposing five–year standards to stabilize the estuary's environmental resources. Under terms of draft D-1630, CVP and SWP operators would have been required to modify maximum export pumping; minimize "reverse flows"; and contribute to and oversee short-term or "pulse flow" releases from upstream reservoirs -- all to increase survival rates for chinook salmon, striped bass and other fish species. A $300 million environmental mitigation fund also was included. Money from this fund would have helped finance the state's share of a host of habitat improvement projects required by the landmark CVP Improvement Act. This act, approved by Congress in 1992, allocated 800,000 acre–feet of CVP water to fish and wildlife and established per–acre–foot mitigation fees, similar to those proposed by the State Board in D–1630.

Through proposed environmental mitigation fees and pulse flows, the State Board was poised to demand -- for the first time -- that all major water diverters, not just the SWP and CVP, take steps to protect the Delta environment. The operational and environmental changes required by D–1630 had the potential to substantially reduce agricultural and urban contractors' surface water supplies -- especially in future droughts -- and, at the same time, increase water costs.

Reaction to D–1630 was mixed. Generally, environmentalists said it did not go far enough and water users said it went too far. However, urban water agencies and environmental groups formed an alliance in general support of the plan, while agricultural water agencies lined up in opposition.

After months of controversy and under increasing political pressure, Gov. Wilson in early April 1993 requested that the State Board drop D–1630 and resume work on permanent standards.Wilson said federal actions to save protected Delta fish species had made D–1630 standards "moot."

The State Board subsequently released a final version of draft D–1630, but said it would not "consider adopting D–1630 as an interim measure, nor will it consider any alternative water right decision until it has prepared environmental documentation" as required by the California Environmental Quality Act. The State Board cited the end of California's severe, multi–year drought and the ESA water project changes required to protect the salmon and Delta smelt as the reasons for its decision.

The State Board has since resumed work on its Environmental Impact Report for permanent Delta standards. Until that process is completed, current water quality rules established under 1978's D–1485 will remain in effect.

EPA vs. State Board?

The EPA's rejection of the State Board's 1991 Delta water quality plan and subsequent threat to impose its own standards under the Clean Water Act set the stage for a federal vs. state conflict over setting water quality standards and overseeing water rights issues.

Federal law under the Clean Water Act gives EPA the power to override a state's water quality standards. But how EPA could force California to implement those rules, whose own laws state only that water quality must be considered when setting water rights, is less clear.

The issue probably will be decided by the courts with California arguing that the state, not the federal government, has authority over water rights, and EPA arguing that its federally developed water quality rules must be met, even if they require an alteration of state water allocation rights.

As of mid–1993, EPA officials said its federal water quality rules for the estuary would be released by year's end.

C-098551

Agreements

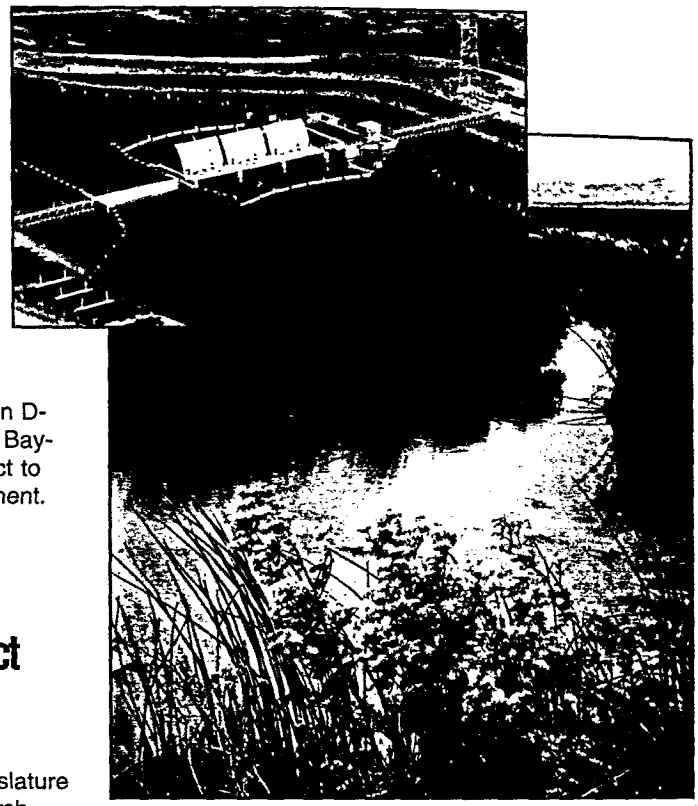
Despite the continuing controversies and conflicts surrounding the Bay–Delta estuary, some water supply and environmental issues are being addressed through innovative interagency agreements and programs. Also, agencies continue to study the Bay–Delta estuary, its water circulation patterns, water project operations and fish and wildlife to gain further understanding of the ecosystem and how best to resolve its problems.

Coordinated Operation Agreement

In 1986, DWR and the Bureau replaced 26 years of annual agreements regarding the responsibilites of each project to meet Delta water quality and flow standards with the historic Coordinated Operation Agreement (COA). The agreement gave additional safeguards to the fragile Delta by committing the Bureau to a share of the responsibility for sustaining flows in the Delta during dry periods.

A major hurdle in reaching agreement was the federal government's reluctance to set a precedent by accepting the state's authority to prescribe water quality requirements for the Delta to be met by the CVP. The concern was resolved by a provision in the COA that authorizes the secretary of the Interior to determine if operating the CVP to meet new state Delta standards would be inconsistent with congressional directives. If the Interior secretary were to make this determination, the federal government would be required to bring a legal action to decide whether the state standards for the Delta apply to the federal CVP.

Coordinated operation is vital for both projects to make the best use of their facilities, but had long been controversial. In times of drought prior to the COA's implementation, the SWP may have been forced to sacrifice the needs of some of its customers to meet State Board Bay–Delta flow and water quality standards if the Bureau did not voluntarily agree to contribute water to meet those standards. Under the COA, the federal government is committed to share with the state the responsibility to meet most of the water quality and flow standards established in D-1485, as well as future Bay-Delta standards, subject to provision in the agreement.



Water quality in Suisun Marsh, above, is maintained through use of fresh water flows to repel sea water and the salinity control gates, inset, which form a physical barrier.

Suisun Marsh Preservation Act

In 1974, the state Legislature passed the Suisun Marsh Preservation Act to preserve and protect the region's unique natural resources. More than 200 species of birds and other wildlife, including the tule elk and the endangered salt marsh harvest mouse, depend on the vegetation that thrives in the region's brackish waters.

Under provisions of the act, the San Francisco Bay Conservation and Development Commission (BCDC), formed in the late 1960s to balance Bay Area development with environmental preservation, adopted a protection plan to regulate dredging, road construction and other activities in the marsh.

In 1987, state and federal representatives of DWR and the Bureau signed an agreement intended to maintain the brackish character of the 57,000 acres of waterways in the marsh, northeast of Carquinez Strait. The agreement is intended to mitigate for changes in the marsh caused by operation of the SWP and CVP and by other upstream diversion of fresh water. The Bureau and DWR each will pay 40 percent of the costs of marsh improvements, and 20 percent will be allocated to other upstream users and reimbursed by the Legislature. To date, approximately $40 million has been spent on marsh improvements.

Those improvements include construction and installation of salinity control gates in Montezuma Slough to control salinity intrusion. The concrete structure, completed in 1988 and weighing 6,100 tons, contains three, 36–foot steel gates. Controlled by computer sensors, the gates open when the water level on the west side is lower, allowing fresh water to enter from the east. When the tides reverse and water starts to drain out of the marsh, the gates close, trapping better–quality water in the marsh and diluting salt water entering from the Bay.

Four Pumps Agreement

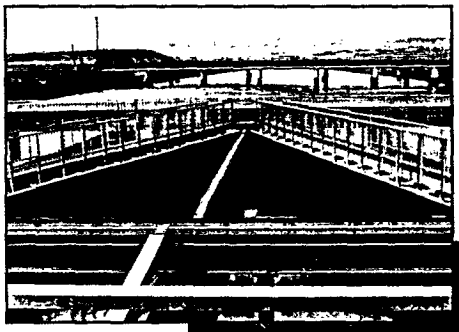
Cooperative efforts also are underway to help restore striped bass, steelhead trout and salmon fisheries under a DFG–DWR agreement to mitigate for losses directly caused by the SWP pumps.Under the provisions of the Delta Pumping Plant Fish Protection Agreement — better known as the "Four Pumps Agreement" — co-signed on Dec. 30, 1986, DWR must mitigate for fish lost at the SWP pumps, including the impacts of adding four new pumps to that facility. Modern fish screens and other bypass facilities are in place to divert fish away from the pumps; however, significant losses still occur as a result of screen inadequacies, predation in Clifton Court Forebay and handling as fish are trucked to release sites in the Delta.

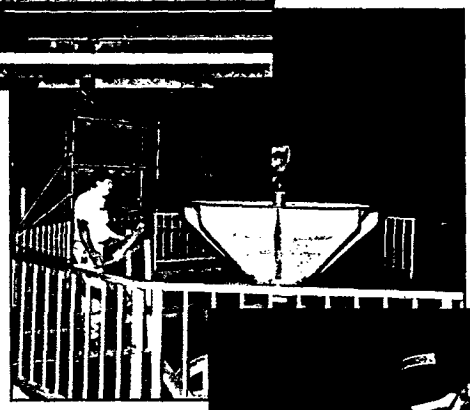
The Bureau signed a similar agreement with DFG in 1992 to compensate for fish lost at its Delta pumps in Tracy. Under the agreement, the Bureau will pay $6.5 million over the next five years to offset the loss of young fish at the pumps, modify and improve the fish collection facility and continue a predator control program to protect young fish.

In 1990, under the Four Pumps Agreement, DWR was obligated to mitigate for about 23,000 yearling steelhead, 791,000 yearling striped bass and 1.3 million juvenile salmon lost at the pumps. At the Skinner Fish Facility upstream from the pumps, fish losses are calculated based on the number of fish recovered at the screens, and specific measures are taken to compensate for these losses.

Article VII of the agreement provides a framework also to mitigate for indirect losses caused by both state and federal facilities. For six years, DFG and DWR, in cooperation with other state and federal agencies and public interest groups, have been working on more than 12 individual mitigation projects to restore populations of these fish. These projects include rearing and stocking striped bass and steelhead, fish hatchery modernizations, spawning gravel replacement, stream flow enhancement and other projects. While the 1987–1992 drought stalled fish recovery efforts throughout the state, fishery specialists remain optimistic that with sufficient rainfall, these projects will be effective.

To date, the most promising mitigation projects have been restoring gravel for salmon spawning in the Sacramento and Merced rivers and increasing flows on Mill Creek (a tributary of the Sacramento River). To increase flows, the Los Molinos Mutual Water Company reduced its diversions from Mill Creek and used ground water, pumped from new wells funded through the agreement, instead. As a result, spring-run salmon counts increased from almost none in 1989 to more than 800 salmon in 1990.





Top: Screens at the SWP pumps in the southern Delta divert fish away from the pumps and into a holding tank. Middle: Fish diverted away from the pumps are collected in this 8–foot diameter bucket. Bottom: Once the diverted fish are measured and counted they are returned to the Delta. Calculations derived from those saved from the pumps are used as basis for the numbers of fish DWR must mitigate for under the Four Pumps agreement.

DWR (through SWP contractors) has funded all projects either through an initial fund of $15 million or through separate annual funding of up to $2 million. In an attempt to address more complex issues, Article VII of the Four Pumps Agreement established a format to mitigate for fish losses due to the indirect impacts of water project operations — problems caused by the volume of water exported from the Delta at certain critical periods in migration cycles or reverse flows which divert fish from their natural migratory patterns.

In fall 1990, the directors of the Bureau, DWR and DFG signed an Article VII "Framework Agreement" outlining the system-wide problems faced by declining fish and wildlife populations in the Delta and offering 28 methods to correct these problems. The methods include reducing Delta water exports at certain times, increasing Sacramento and San Joaquin rivers flows into the Delta, installing new fish screens, reducing the discharge of toxic substances into Delta waters and changing SWP and CVP operations to speed fish outmigration through the Bay. Because indirect losses can be very difficult to quantify, negotiating the specifics of recovery plans to compensate for estimated or unknown losses can be a lengthy and contentious process. Negotiations continue on a monthly basis.

C-098553

Plans and Programs

Peripheral Canal

The pros and cons of the Peripheral Canal are still debated more than a decade after voters defeated a controversial canal/water-development package. The prolonged drought, a need for more reliable water supplies, concern about drinking water quality, fear of levee collapse after a major earthquake and the pressing need to protect Delta fisheries have revived intrest in — and debate on — an "isolated transfer facility."

The voter–approved 1960 Burns-Porter Act included Delta facilities as part of the SWP, and in 1964, the Interagency Delta Committee recommended that a peripheral canal be built to skirt the eastern edge of the Delta. In 1977, DWR proposed an amalgam of joint state-federal programs and facilities, later to become Senate Bill 200, which included a 42-mile long peripheral canal to circumvent the maze of Delta channels and more efficiently carry water from the Sacramento River south to CVP and SWP pumping plants. Fresh water would be released into the Delta at strategic points for irrigation, fish and wildlife enhancement, and to repel salt water intrusion. As a compromise to some northern Californians, a provision was added guaranteeing more protection for the Delta and north coast rivers.

Proponents argued that the canal would help avoid the problem of "reverse flows" which occur when Delta inflow is low and exports are high. The powerful south Delta project pumps actually reverse the natural flow of fresh water through the estuary, drawing water east and south rather than west into the Bay. Not only does this disorient migratory salmon, steelhead and bass and draw fish into project pumps, but under very dry conditions, saltier ocean water also is drawn upstream into the San Joaquin River and other channels.

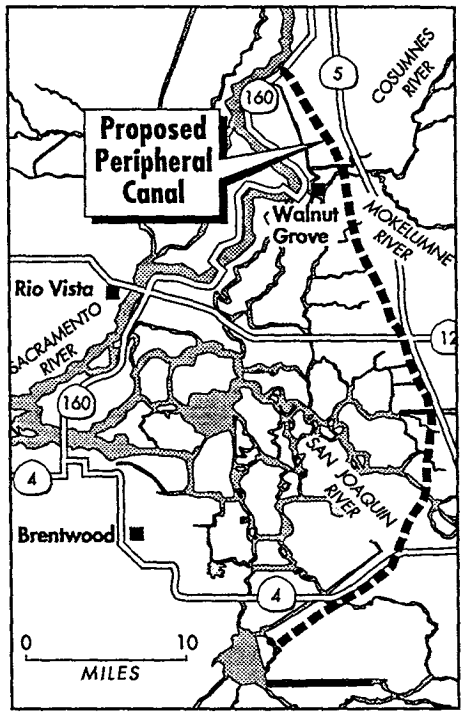
But some northern Californians and environmentalists feared the canal would open the door for increased water exports to central and southern California, and the debate fueled California's long-standing north-south water wars.

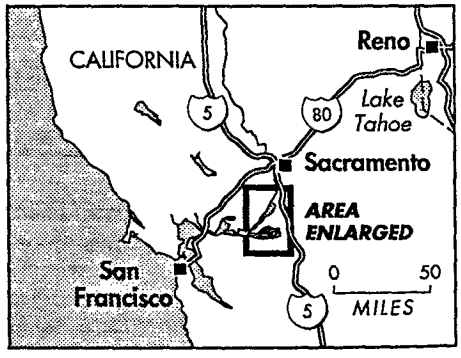
After much controversy, a referendum on the bill, Proposition 9, was defeated in 1982, primarily because of cost (in 1981 dollars the entire water package, including the Peripheral Canal, was estimated at $3.1 billion) and environmental concerns.

Following defeat of Proposition 9, there have been other attempts to approve a Delta water transfer facility. In 1983, the Deukmejian Administration proposed four Delta alternatives to the Peripheral Canal. One was chosen, and in 1984, SB 1369 was introduced. SB 1369 was estimated at $1.1 billion and included construction of a new 10– to 14–mile–long canal linking the Sacramento and Mokelumne rivers (the New Hope Cross Channel, or "Duke's Ditch," as it was dubbed by opponents), widening existing Delta channels, construction of three new reservoirs south of the Delta and financing levee maintenance and fishery restoration. If completed, the package would have moved an additional 630,000 acre-feet of water a year through the Delta. In August 1984, however, Gov. Deukmejian dropped the bill when it became clear it would not receive enough support in the Legislature and might be subjected to voter referendum.

Delta legislation enacted in 1984 did authorize construction of an offstream storage reservoir south of the Delta, Los Banos Grandes, with the capacity to store 1.75 million acre-feet of excess surface water during peak runoff periods. The reservoir's greatest benefit to the Delta, according to DWR, would be increased flexibility of operation that could help offset the impacts of export pumps on Delta fish. Some initial planning and environmental work on the reservoir has been conducted, but there is concern that water export restrictions imposed to protect threatened species will reduce the amount of excess flow available for export — making it more difficult to fill Los Banos Grandes.

DWR also is proceeding with plans to widen and deepen key Delta channels so that fresh water can flow more efficiently to project pumps. These planning efforts are divided into three separate programs, North Delta, South Delta and West Delta.





North Delta planning has two main goals: eliminate reverse flows and reduce flooding along the lower Mokelumne River. Proposed solutions to both problems is to widen and deepen key Delta channels, increasing their carrying capacity and reducing flooding risks caused by state and federal pumping.

In the South Delta, DWR has proposed widening Clifton Court Forebay, enlarging the Middle River to improve water circulation, utilizing the full capacity of the SWP's Harvey Banks Pumping Plant to capture winter runoff, and constructing up to four channel barriers to improve water levels and circulation.

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In the West Delta, DWR is investigating turning Sherman and Twitchell islands into wetlands, reducing the potential for levee failure and providing more than 10,000 acres of wildlife habitat. These islands are at the westernmost point of the estuary and are at, or closest to, the point where salt water from the Bay meets fresh water from the rivers. In 1991, Sherman Island landowners signed an agreement that supported land purchases, and DWR is proceeding on a "willing buyer" and "willing seller" basis. On Twitchell Island, about 80 percent of its 3,600 acres have been acquired for habitat development. Negotiations for the remaining acreage continue.

Interagency Ecological Studies Program

The Interagencies Ecological Studies Program (IESP) was established in 1970 by DFG, DWR, the Bureau and USFWS. Since then, three more agencies — the U.S. Geological Survey, Corps and State Board — joined the program. Testimony indicating that construction of the CVP and SWP contributed to environmental damage in the estuary during hearings on the State Board's D–1379 (1971) led to creation of the IESP.

The IESP was formed to gather further information on fish and wildlife resources in the Bay and Delta. Currently there are five IESP study elements: fisheries, evaluating salmon, striped bass and other fish; water quality, assessing the impacts of water development on the food chain; fish facilities, obtaining a better understanding of effects of existing Delta pumping facilities on fish; Delta outflow, developing information on the need for Delta outflow to protect the Bay; and hydrodynamics, evaluating fresh water inflow numbers and circulation.

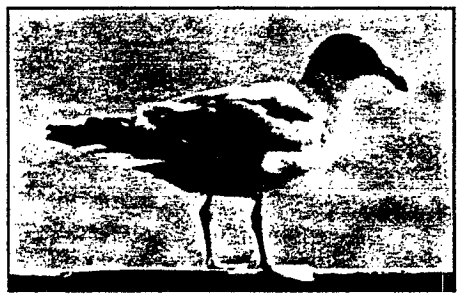
The IESP annually presents its findings to the State Board. For the 1992–93 fiscal–year, the ISEP budget was more than $9 million, with funding provided by the participating agencies.

One experimental project funded, in part, by IESP in 1993 was a sound barrier at Georgiana Slough. The slough, located just south of Walnut Grove, transports Sacramento River water to the export pumps. Through use of underwater speakers, scientists and water users attempted to discourage fall–run juvenile salmon from entering the slough, directing them to remain in the main river channel on their out–migration toward the Bay. If the experiment's results are positive, the barrier could be used at other times of the year and at other locations to prevent diversion pumps from killing migrating salmon.

Aquatic Habitat Institute

The Aquatic Habitat Institute (AHI) was established in 1982 at the recommendation of the State Board. It was founded in recognition of the need to develop a more comprehensive scientific understanding of the impacts of human activities on the ecology of the Bay and Delta. Set up as an independent, nonprofit corporation with the purpose of evaluating the effects of pollution on the estuary, AHI's charge is to coordinate research and monitoring efforts related to pollutants in the estuary, and publish research and findings.

AHI has developed computer data bases compiling research and monitoring programs that have been or are now being conducted in the Bay–Delta Estuary. Interested parties may access the data bases at no charge. Plans to broaden the scope of the studies, and assume the name San Francisco Estuarine Institute are expected to be completed by December 1993.



San Francisco Estuary Project

In 1986, the San Francisco Bay–Delta estuary was added to the EPA's National Estuary Program, established and funded under the Clean Water Act. Another 21 estuaries (mostly on the East Coast) are included in the program, which attempts to protect and improve water quality and enhance natural resources. (The San Francisco project was reauthorized in 1988.)

In 1992, the San Francisco Estuary Project released reports identifying five management issues of concern and detailing a plan to restore and maintain the Bay and Delta. The five issues of concern identified in the Comprehensive Conservation and Management Plan (CCMP) are: a decline of natural resources; increased pollutants; increased dredging and waterway modification; intensified land use; and fresh water diversions and altered flow regime.

The most controversial portion of the CCMP is its call for the adoption of "water quality and flow standards and operational requirements to halt and reverse the decline of indigenous and desirable estuarine biota." The document does not specifiy how much more fresh water outflow is needed to meet this goal. Some disagreements remain as to the study's findings. For example, DWR contends the Estuary Project's flow recommendations are inconsistent with state water policy because they did not balance environmental protection with economic factors. On the other hand, some environmentalists say the flows are not enough to protect the estuary.

The Clean Water Act says the estuary plans are to be implemented, although concurrence from state governors is required in order for the affected states to gain federal money to implement the plan. As of mid–1993, the plan was awaiting action by Gov. Wilson, and some portions were being implemented.

Summary

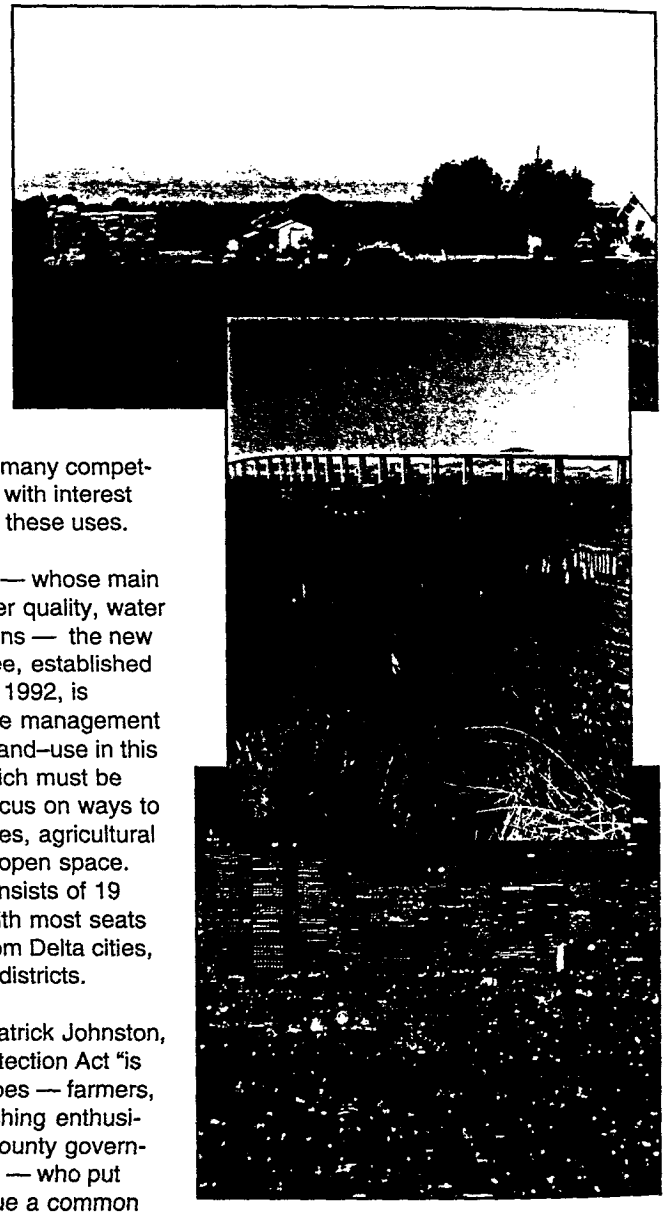
The Delta is a region of multiple uses. Its islands' rich soil nourishes an agricultural cornucopia, while the labyrinth of Delta sloughs serves as a recreational playground for boaters and fishermen. The mix of fresh water from Delta rivers and salt water from San Francisco Bay sustains a diverse population of flora and fauna. The Delta also is the heart of California's largest water delivery systems, the CVP and the SWP, whose waters are the lifeblood for 20 million residents, the state's $700 billion industry and more than 4 million acres of productive farmland, primarily in the San Joaquin Valley.

The Delta has long been a subject of conflict and controversy -- especially when it comes to water allocations for farms, cities, fish and wildlife. Over the last decade, a number of factors has increased pressure on the fragile Delta system and heightened interest in attaining a solution to Delta problems. These factors include a precipitous decline in many fish species that live in or migrate through the Delta, laws and public pressure to protect the environment, unprecedented urban population growth and a corresponding need for more water, and the 1987–1992 drought.

Add to these issues the concern over the deterioration of Delta levees, drinking water quality and salinity intrusion and it becomes even more complicated. Because of all these factors, there is no simple solution to the Delta dilemma. The many local, state and federal agencies all attempting to come up with solutions for Delta problems often work at cross purposes. The variety of Delta issues and number of special interest groups have added to the long and drawn–out process of addressing and solving local Delta problems and statewide water issues.

Over the last decade, the defeat of Proposition 9 (the Peripheral Canal ballot package), the prolonged drought, and the increasing influence of environmental laws and protection measures have prompted the three water–user groups to seek a consensus on Delta issues, but *none appears near.*

The Three–Way Group, Gov. Wilson's subsequent Bay–Delta committee and other groups, such as the Committee for Water Policy Consensus and the San Francisco Estuary Project, were formed to study the Bay–Delta Estuary and seek compromises and consensus on this vital area. Whether these ventures can succeed is uncertain, for as this guide illustrates, there are many competing uses for the estuary — with interest groups existing for each of these uses.



In addition to these efforts — whose main focus continues to be water quality, water outflow and water allocations — the new Delta Protection Committee, established by the state Legislature in 1992, is meeting to draft a resource management plan that will guide future land–use in this fragile area. This plan, which must be completed by 1994, will focus on ways to protect existing Delta levees, agricultural lands, wildlife habitat and open space. The Delta Commission consists of 19 state and local officials, with most seats held by elected officials from Delta cities, counties and reclamation districts.

According to state Sen. Patrick Johnston, D–Stockton, the Delta Protection Act "is the product of traditional foes — farmers, environmentalists, sportfishing enthusiasts, biologists, city and county governments and water agencies — who put aside their biases to pursue a common goal of protecting the Delta from death by development."

Whether the state's many environmental, urban and agricultural interest groups can come together to reach consensus and draft similar agreements for water use, water development and fish and wildlife protection remains to be seen. It will not be an easy task because it will require that tough decisions be made, difficult agreements be forged and that each interest group not only gain, but also lose something.

As difficult as it sometimes seems for California's diverse water interests to agree on anything, all factions seem to now realize that only through compromise and innovative thinking will the state solve this Delta dilemma — and its current water crisis. Using new strategies to meet supply demands, comply with environmental protection and resolve water quality problems is the challenge that the state's residents and water managers will face into the next century.